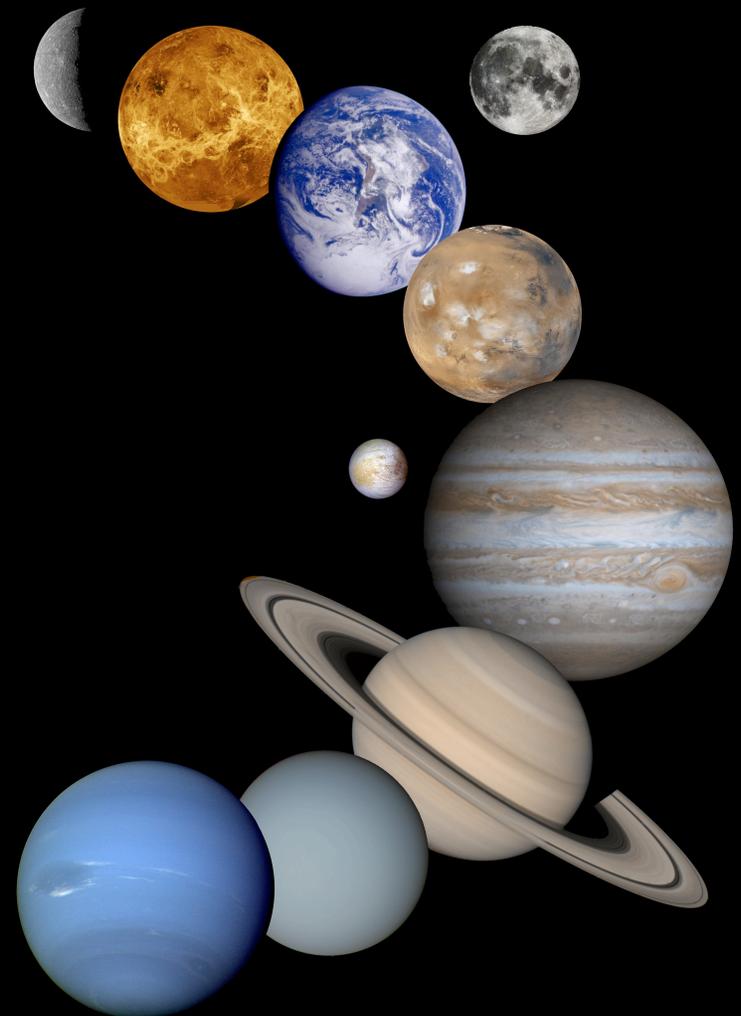
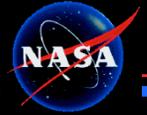




Planetary Protection for Discovery AO 2010

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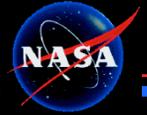


NASA Planetary Protection Policy

NPD 8020.7G

POLICY

The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial sources. Therefore, for certain space-mission/target-planet combinations, controls on organic and biological contamination carried by spacecraft shall be imposed in accordance with directives implementing this policy



NASA Planetary Protection Policy Implementing Documents

NPR 8020.12C (in revalidation)

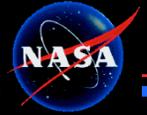
"Planetary Protection Provisions for Robotic Extraterrestrial missions"

- » Defines PP mission categories
- » Details Planetary Protection requirements
- » Establishes schedules for documentation and reviews
- » Includes Planetary Protection parameter specifications

NHBK 6022 (in press)

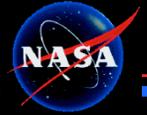
"NASA Standard Procedures for the Microbial Examination of Space Hardware"

- » Defines procedures for the microbiological examination of space hardware and associated environments



Planetary Protection Mission Categories

Planet Priorities	Mission Type	Category	Example
Not of direct interest for understanding the process of chemical evolution. No protection of such planets is warranted (no requirements)	Any	I	Lagrange missions
Of significant interest relative to the process of chemical evolution, but only a remote chance that contamination by spacecraft could jeopardize future exploration.	Any	II	Lunar missions(new) Stardust (outbound) Genesis (outbound) Cassini
Of significant interest relative to the process of chemical evolution and/or the origin of life or for which scientific opinion provides a significant chance of contamination which could jeopardize a future biological experiment.	Flyby, Orbiter	III	Odyssey MGS MRO
	Lander, Probe	IV	MER Phoenix Viking MSR (outbound)
Any solar system body	Unrestricted Earth return	V	Stardust (return) Genesis (return)
	Restricted Earth return	V	MSR (return)



Planetary Protection Documentation Schedule

Mission Categorization

- Communicate with PPO in pre-Phase A
- Formal request to PPO during Phase A (discuss implementation by SRR)
- Categorization letter received by KDP B

Planetary Protection Plan (II-V)

- Drafted during Phase B (consult with PPO)
- Released by PDR (included in review)
- Approved by KDP C

Pre-launch Planetary Protection Report

- due 90 days prior to Launch; (Launch Certification at FRR for Cat. III-Vr)

Post-launch Planetary Protection Report

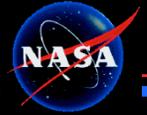
- due 60 days post Launch

Extended Mission Planetary Protection Plan

- Approved prior to end of original Phase E (KDP F)

End-of-Mission Report

- due 60 days after End of Mission



Planetary Protection Requirements by Category

Category

II

General Requirement

Documentation only

- Planetary Protection Plan
- Prelaunch Planetary Protection Report
- Postlaunch Planetary Protection Report
- End-of-Mission Report

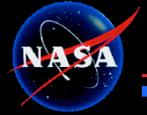
III

Implementing Procedures (as required)

- Trajectory biasing
- Clean room assembly
- Microbial reduction or orbital lifetime

Documentation

- Same as Category II plus
- Subsidiary plans (as required)



Planetary Protection by Mission Category (cont'd)

Category
IV

General Requirement

Implementing Procedures

- Trajectory biasing
- Clean room assembly
- Microbial reduction
- Organics inventory and archive

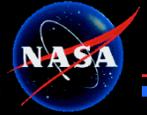
Documentation

- Same as Category III plus
- Subsidiary plans

V

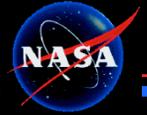
Outbound Implementing Procedures and Documentation as per outbound categorization

Inbound requirements if 'Restricted Earth Return' are additional Documentation, return/reentry certification requirements, and Sterilization or containment at Biosafety Level IV



Categorizations are determined

- on a mission-by-mission basis
- based on recommendations from the Planetary Protection Subcommittee of the NASA Advisory Council
- considering advice from the Space Studies Board of the National Research Council



Relevant Planetary Protection Reports by the Space Studies Board

1992

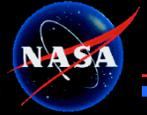
- *Biological Contamination of Mars: Issues and Recommendations*, which reported advice to NASA on measures to protect Mars from contamination by Earth organisms, as well as overall policy guidance (Ken Nealson, Chair)

1998

- *Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies*, which reported a framework for decision making (Leslie Orgel, Chair) <<http://books.nap.edu/books/0309061369/html>>

2000

- *Preventing the Forward contamination of Europa*, provided provided advice to NASA on measures to protect Europa from contamination by Earth organisms. (Larry Esposito, Chair) <<http://books.nap.edu/books/NI000231/html>>



Category II Requirements: Venus, the Moon, and (most) Small Bodies

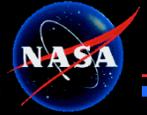
Documentation:

- Planetary Protection Plan (what the project will do)
- Prelaunch Planetary Protection Report (what was done so far)
- Postlaunch Planetary Protection Report (spacecraft working?)
- End-of-Mission Report (where did it go, where is it now)

Standard spacecraft assembly procedures (cleanrooms, etc.)

N.B.: Missions to the Moon must provide an inventory of organic materials (≥ 1 kg) carried on the spacecraft (per COSPAR Policy, 2008)

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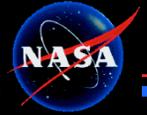
Category III/IV Requirements for Mars

Category III: Mars orbiters are required either to meet orbital lifetime requirements* or to carry a total bioburden of $\leq 5 \times 10^5$ spores total, including surface, mated, and embedded bioburden

** Defined as 20 years after launch at greater than or equal to 99% probability, and 50 years after launch at greater than or equal to 95% probability.*

Category IV for Mars is subdivided into IVa, IVb, and IVc:

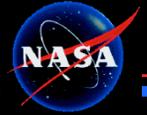
- Lander systems not carrying instruments for the investigations of extant martian life may carry $\leq 3 \times 10^5$ surface spores, and ≤ 300 spores per m^2 (Cat. IVa)
- Lander systems searching for life (Cat. IVb) or entering special regions (IVc) must reduce this by a further 10^4
- Impacting hardware may carry $\leq 5 \times 10^5$ spores total, including surface, mated, and embedded bioburden



Category III/IV Requirements for Europa and other icy moons

- Requirements for spacecraft targeting icy moons shall be imposed to reduce the probability of inadvertent contamination of any liquid water body to less than 1×10^{-4} per mission
- Even missions that don't "target" an icy moon must meet this requirement: e.g. Juno must show less than 1×10^{-4} probability of contaminating Europa
- The physics of multi-moon systems destabilizes orbits, so End of Mission scenarios must address the potential for contamination after the mission ends

This may require pre-launch microbial reduction

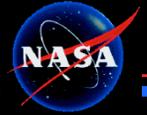


Calculations must consider:

1. Microbial burden at launch (number and type)
2. Survival of contaminating organisms during cruise
3. Organism survival in the radiation environment of the active mission
4. Probability of surviving impact or landing on the target body
5. Mechanisms of transport to the subsurface
6. Organism survival and proliferation

Use the Europa specification sheet in 8020.12C
and Appendix A of the SSB Europa report

Assumptions must be conservative



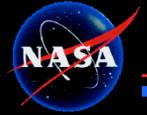
Requirements for Sample Return Missions

Category V

All Earth-return missions. The concern for these missions is the protection of the terrestrial system, the Earth and the Moon (The Moon must be protected to retain freedom from requirements on Earth-Moon travel.)

Subcategories:

- “Unrestricted Earth Return”
 - For solar system bodies deemed to have no potential for life
 - Requirements on the outbound phase only (typically Category I or II)
- “Restricted Earth Return”
 - Absolute prohibition of destructive impact upon return
 - Containment throughout the return phase of all returned hardware which directly contacted the target body or unsterilized material from the body
 - Containment of any unsterilized sample, collected and returned to Earth
 - Post-mission analyses of the unsterilized sample, under strict containment using the most sensitive techniques. If any sign of existence of a non-terrestrial replicating entity, is found, the returned sample must remain contained unless treated by an effective sterilizing procedure.



End of Mission Scenarios

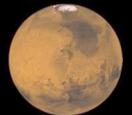
- For all missions, end-of-mission scenarios that account for the disposition of a radioisotope power source (RPS) may choose to demonstrate orbital lifetime beyond the effective lifetime of the heat source, a burn-up/break-up analysis demonstrating that the RPS would not create a biological contamination concern, or directed disposal of the spacecraft into an object that is not of concern for biological contamination.

Missions must address the potential for creating an habitable environment if a heat source is present

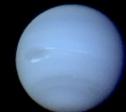
Questions?



Planetary Protection



All of the Planets, All of the Time...



...Including Pluto and All the Rest!

